AN ANALYSIS OF THE AQUATIC INVERTEBRATES AND HABITAT OF COTTONWOOD CREEK, FERGUS COUNTY, MONTANA

August 2001

A report to

The Montana Department of Environmental Quality
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by

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INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in August 2001 from three sites on Cottonwood Creek, a tributary of Big Spring Creek in Fergus County, Montana. Aquatic invertebrate assemblages were sampled by personnel of the Montana Department of Environmental Quality (DEQ). Study sites lie within the Northwestern Plains ecoregion (Woods et al. 1999). A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is " ...a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment..." (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1995). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998). The first of these is an appropriate stratification or classification of stream sites, typically, by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied is needed to assist in the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat parameters and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998) has recently studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion, and has recommended a battery of metrics applicable to the montane ecoregions of western Montana. This metric battery has been shown to be sensitive to impairment, related to habitat assessment parameters, and consistent over replicated samples.

Habitat assessment enhances the interpretation of biological data (Barbour and Stribling 1991), because there is generally a direct response of the biological community to habitat degradation in the absence of water quality impairment. If biotic health appears more damaged than the habitat quality would predict, water pollution by metals, other toxicants, high water temperatures, or high levels of organic and/or nutrient pollution might be suspected. On the other hand, an "artificial" elevation of biotic condition in the presence of habitat degradation may be due to the paradoxical effect of mild nutrient or organic enrichment in an oligotrophic setting.

METHODS

Aquatic invertebrates were sampled by Montana DEQ personnel on August 21, 2001. Three sites were sampled. Site locations and sampling dates are indicated in Table 1. The sampling method employed was that recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). In addition to aquatic invertebrate sample collection, habitat quality was visually evaluated at each site and reported by means of the habitat assessment protocols recommended by Bukantis (1998).

Evaluated habitat features include instream conditions, larger-scale channel conditions including flow status, streambank condition, and extent of the riparian zone. Scores were assigned in the field to each habitat measure, and these scores were totaled and compared to the maximum possible score to give an overall assessment of habitat.

Aquatic invertebrate samples and associated habitat data were delivered to Rhithron Biological Associates, Missoula, Montana, for laboratory and data analyses. In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities in this study, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998) was used, since these metrics are probably pertinent to the evaluation of Cottonwood Creek. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence. Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics, which have been shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, however, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics comprising the bioassessment index used in this study were selected because both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998). In addition, they are relevant to the kinds of impacts that are present in Cottonwood Creek drainage. They have been demonstrated to be more variable with anthropogenic disturbance than with natural environmental gradients (Bollman 1998). Each of the six metrics developed and tested for western Montana ecoregions is described below.

Table 1. Sampling sites and dates: three sites on Cottonwood Creek. Sites are listed from upstream to downstream.

Site designation	Site description	Sampling Date	GPS Location Lat.	Long.
1	Cottonwood Creek	8/21/01	46°57'46"N	109°29'05"W
2	Cottonwood Creek: below Beaver Creek confluence	8/21/01	47°05'28"N	109°35'59"W
3	Cottonwood Creek: near mouth	8/21/01	47°07'34"N	109°34'18"W

1. **Ephemeroptera (mayfly) taxa richness.** The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.
2. **Plecoptera (stonefly) taxa richness.** Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.
3. **Trichoptera (caddisfly) taxa richness.** Caddisfly taxa richness has been shown to decline when sediment deposition affects their habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.
4. **Number of sensitive taxa.** Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998).
5. **Percent filter feeders.** Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* sp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are

considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.

6. **Percent tolerant taxa.** Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 2. Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for this metric battery.

Table 2. Metrics and scoring criteria for bioassessment of streams of western Montana ecoregions (Bollman 1998).

	Score			
metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 – 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 – 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 – 35	> 35

The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3a.

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman, unpublished data). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature, substrate embeddedness, and fine sediment (Bollman 1998). In a study of reference streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).
- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman, unpublished data).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles. Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman, unpublished data).

Table 3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis, 1997).	
% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table 3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989).	
% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

RESULTS

Habitat assessment

Figure 1 compares habitat assessment results for the 3 sites in this study. Table 4 itemizes the evaluated habitat parameters and shows the assigned scores for each.

Figure 1. Total habitat assessment scores for sites on Cottonwood Creek, August 2001. Sites are listed from upstream to downstream.

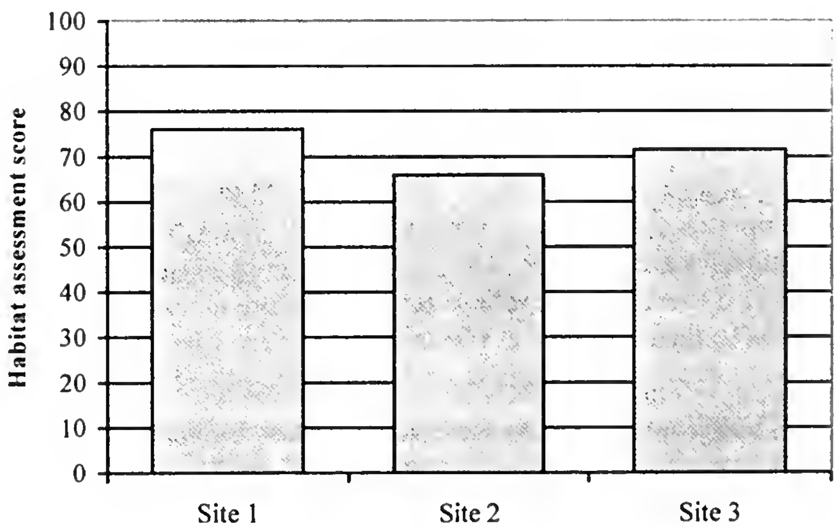


Table 4. Stream and riparian habitat assessment. Two sites (Sites 1 and 2) were assessed based upon criteria developed by Montana DEQ for streams with riffle/run prevalence, while the downstream site (Site 3) assessment was based upon criteria developed for streams with glide/pool prevalence. Cottonwood Creek, August 2001.

Max. possible score	Parameter	Site 1	Site 2
10	Riffle development	8	8
10	Benthic substrate	6	5
20	Embeddedness	17	11
20	Channel alteration	17	16
20	Sediment deposition	8	7
20	Channel flow status	14	6
20	Bank stability	10 / 10	7 / 9
20	Bank vegetation	9 / 9	9 / 9
20	Vegetated zone	6 / 8	8 / 10
160	Total	122	105
	Percent of maximum	**76**	**66**
	CONDITION*	**SUB-OPTIMAL**	**SUB-OPTIMAL**

Max. possible score	Parameter	Site 3
20	Bottom substrate	15
20	Pool substrate char.	16
20	Pool variability	7
20	Channel alteration	19
20	Sediment deposition	13
20	Channel sinuosity	15
20	Channel flow status	10
20	Bank vegetation	8 / 8
20	Bank stability	7 / 7
20	Vegetated zone	9 / 9
200	Total	143
	Percent of maximum	**71.5**
	CONDITION*	**SUB-OPTIMAL**

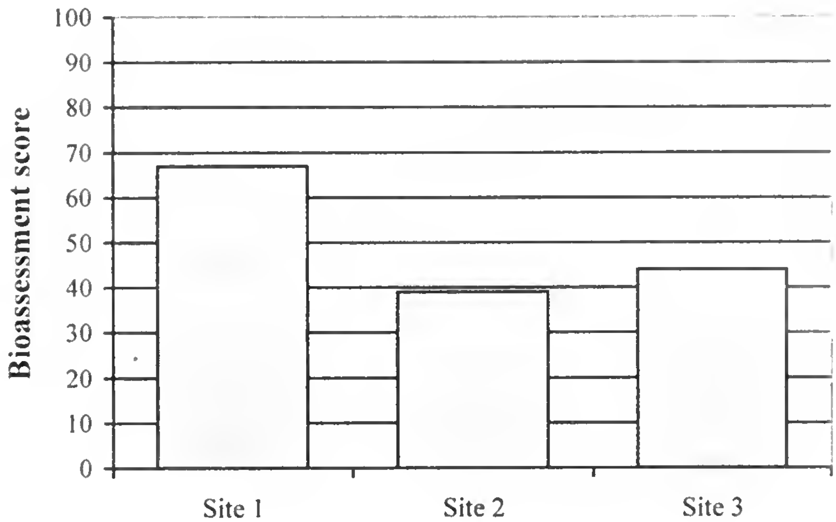
* Condition categories: Optimal (OPT) > 80% of maximum score; Sub-optimal 75 - 56%; Marginal (MARG) 49 - 29%; Poor <23%. Adapted from Plafkin et al. 1988.

Habitat was judged sub-optimal at all three Cottonwood Creek sites. At Sites 1 and 2, fine sediment deposition appeared to be the predominant impairment to habitat quality. At Site 2, habitat was further compromised by low flow, which the investigator attributed to the droughty year, and further suggested that diversion upstream possibly reduced flow further still. At Site 3, flow conditions were rated marginal, and pool habitat was perceived to be limited.

Bioassessment

Macroinvertebrate taxa lists, metric results, and other information for each sample are given in the Appendix. Figure 2 compares the total bioassessment scores calculated for macroinvertebrate communities collected at each of the three sites. Breakdown of scores for each metric calculated from Cottonwood Creek aquatic invertebrate samples is presented in Table 5.

Figure 2. Total bioassessment scores, expressed as percent of maximum, for three sites on Cottonwood Creek, August 2001.



Partial support of designated uses was indicated by bioassessment scores for all three sites on Cottonwood Creek, based on this analysis of the aquatic invertebrate assemblages. Scores suggested that biotic health was slightly impaired at the uppermost site (Site 1) and moderately impaired at the two sites downstream (Sites 2 and 3).

At the upstream site (Site 1), no sensitive taxa were present in the sample, and the relative abundance of tolerant taxa was higher than expected. At the intermediate site, neither Plecoptera nor sensitive taxa were collected, and the proportion of tolerant taxa was higher than expected. Filter-feeders were also more abundant than expected. At the site near Cottonwood Creek's confluence with Big Spring Creek, Plecoptera taxa richness was low, and there were no sensitive taxa in the sample. The abundances of both filter-feeders and tolerant taxa exceeded expectations.

Table 5. Metric values and bioassessments for Cottonwood Creek, August 2001.

	SITES		
	Site 1	Site 2	Site 3
METRICS	**METRIC VALUES**		
Ephemeroptera richness	6	6	4
Plecoptera richness	4	0	1
Trichoptera richness	6	6	5
Number of sensitive taxa	0	0	0
Percent filterers	4	17	18
Percent tolerant taxa	66	42	32
	METRIC SCORES		
Ephemeroptera richness	3	3	2
Plecoptera richness	3	0	1
Trichoptera richness	3	3	3
Number of sensitive taxa	0	0	0
Percent filterers	3	1	1
Percent tolerant taxa	0	0	1
TOTAL SCORE (max.=18)	12	7	8
PERCENT OF MAX.	**67**	**39**	**44**
Impairment classification*	**SLI**	**MOD**	**MOD**
USE SUPPORT †	**PART**	**PART**	**PART**

1. Classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired. (SEV) severely impaired. See Table 3b.

*Use support designations: See Table 3a.

Aquatic invertebrate communities

Six mayfly taxa were collected at the upstream site on Cottonwood Creek (Site 1), yet the modified biotic index score (5.56) was elevated compared to expectations, and no sensitive taxa were collected. These findings may suggest that water quality at the site was unimpaired by nutrients, metal, or other polluting inputs, but that water temperature may be somewhat elevated compared to the reference conditions from which this bioassessment method was developed. Taxonomic clues seem to support this hypothesis: lymnaeid (*Fossaria* sp.) and physid snails were plentiful at this site. In fact, they comprised 28% of organisms in the sample. Nine "clinger" taxa and 6 caddisfly taxa were present, suggesting that fine sediment deposition did not substantially interfere with benthic habitat condition. High total taxa richness (33) and abundant predator fauna (7 taxa) imply that complex and abundant habitats were generally available. All functional components of a healthy benthic assemblage were present in the sample taken at this site. The presence of fauna typically oriented to slack water environs, such as immature corixids and mature *Sigara* sp., as well as the large number of dytiscid beetles (*Oreodytes* sp.), seems to indicate that back water habitats were sampled along with riffle habitats. Six long-lived taxa were present at the site, suggesting that dewatering or other catastrophic events have not regularly interrupted life cycles at this site on Cottonwood Creek.

The intermediate site on Cottonwood Creek (Site 2), located below the confluence with Beaver Creek, exhibits more impairment of biotic health than do the other 2 sites visited. While water quality indicators performed similar at both Site 1 and Site 2, with similar suggestions of good water quality in terms of chemistry but elevated water temperature, some habitat indicators did not give such positive results. No stoneflies were taken at this site, suggesting that disturbance of reach scale habitat features may impair biotic health at this site. Such disturbances could include loss of riparian zone function, extensive unstable streambanks, channel alteration, or other factors. Another disturbing feature of the invertebrate assemblage at this site was the relatively low number of long-lived taxa; among the 4 such taxa present in the sample, none were abundant. In all, they comprised 3% of the sampled assemblage. Water diversion or extreme drought may impair biotic health at this site. Six caddisfly taxa and 9 "clinger" taxa were collected, suggesting that fine sediment deposition did not obliterate benthic habitats, however, the taxonomic composition of the sampled assemblage gives some evidence that fine sediments were present in some locations at the site. Sediment-preferring taxa in the sample include the mayflies *Caenis* sp. and *Ephemera* sp., and the caddisfly *Helicopsyche borealis*, which was abundant in this location.

Water quality appeared to be somewhat more degraded in Cottonwood Creek near its mouth. Mayfly taxa richness (4) was more depressed than at the upstream sites, while the modified biotic index value (5.36) remained higher than expected. Faunal components continue to indicate warm water temperatures; in addition, some indicators of anoxic benthic sediments appeared in the sample, namely the midges *Dicrotendipes* sp. and *Microtendipes* sp. Neither of these, however, was particularly abundant. Instream habitats were probably mostly intact, since 5 caddisfly taxa and 11 "clinger" taxa were collected, taxa richness (32) was high, and 4 predator taxa were present at the site. Three individuals of an immature perlodid stonefly were taken in the sample, suggesting that reach-scale disturbance may influence benthic assemblages. In addition, only 3 long-lived taxa were represented in the sample; dewatering may be a problem at this site.

CONCLUSIONS

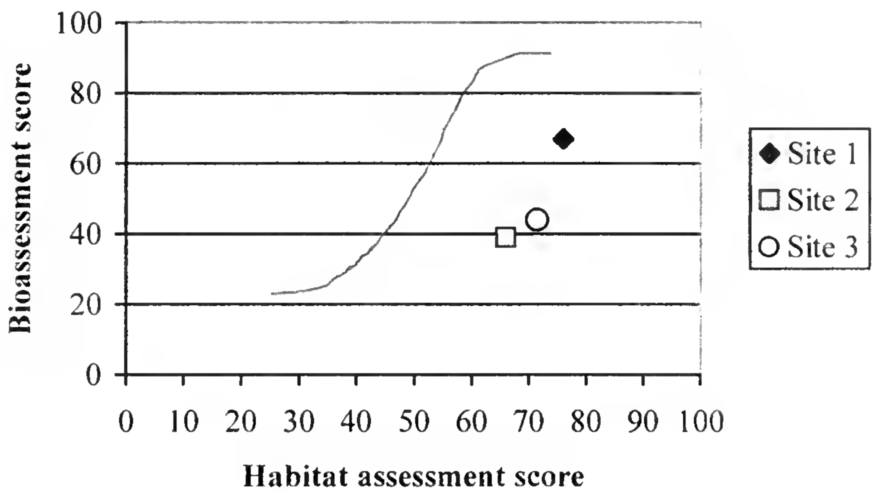
- Chemical water quality appeared to be unimpaired by chemical or nutrient inputs at all three Cottonwood Creek sites, though water temperatures appeared to be elevated at all visited sites.

- Fine sediments do not seem to substantially impair biotic health at any site, but taxonomic evidence of some deposition could be seen at Site 2.

- Dewatering or other catastrophic interruptions of long life cycles may impair biotic potential at Sites 2 and 3.

- The relationship between habitat assessment scores and bioassessment scores is illustrated in Figure 3. The red curve in the center of the graph represents the hypothetical relationship between habitat quality and biotic health when habitat degradation is the sole source of impairment to benthic assemblage health (Barbour and Stribling 1991). Symbols which fall below the line indicate that bioassessment scores are somewhat lower than would be expected if impairment were due to habitat degradation alone, and suggests that water quality impairment, perhaps by elevated temperatures, was the predominant factor limiting biotic health in these reaches of Cottonwood Creek.

Figure 3. Total bioassessment scores plotted against habitat assessment scores for three sites on Cottonwood Creek, August 2001. The red line describes the hypothetical relationship expected when water quality is good and biotic health is determined predominantly by habitat quality (Barbour and Stribling 1991).



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APPENDIX

Taxonomic data and summaries

Cottonwood Creek

August 2001

Aquatic Invertebrate Taxonomic Data

Site Name: Cottonwood Creek

Site ID: M22CTWDC01 8/21/01

Approx. percent of sample used: 100

Taxon	Quantity	Percent	HBI	FFG
Tubificidae - immature	1	0.39	9	CG
Fossaria sp.	16	6.30	6	CG
Physidae	55	21.65	8	CG
Gyraulus sp.	4	1.57	8	SC
Total Misc. Taxa	**76**	**29.92**		
Acentrella turbida	1	0.39	4	CG
Baetis tricaudatus	18	7.09	6	CG
Diphetor hageni	4	1.57	5	CG
Drunella grandis	3	1.18	2	CG
Nixe sp.	13	5.12	2	SC
Paraleptophlebia bicornuta	35	13.78	4	CG
Total Ephemeroptera	**74**	**29.13**		
Sweltsa sp.	5	1.97	1	PR
Zapada cinctipes	1	0.39	2	SH
Hesperoperla pacifica	2	0.79	2	PR
Perlodidae-early instar	1	0.39	2	PR
Total Plecoptera	**9**	**3.54**		
Corixidae - immature	22	8.66	8	UN
Sigara sp.	4	1.57	8	PH
Total Hemiptera	**26**	**10.24**		
Brachycentrus occidentalis	3	1.18	1	OM
Helicopsyche borealis	1	0.39	7	SC
Hydropsyche sp.	7	2.76	4	CF
Lepidostoma sp.-turret case larvae	5	1.97	2	SH
Oecetis sp.	4	1.57	8	OM
Wormaldia sp.	1	0.39	3	CF
Total Trichoptera	**21**	**8.27**		
Oreodytes sp.	30	11.81	5	PR
Cleptelmis sp.	1	0.39	4	CG
Optioservus sp.	2	0.79	4	SC
Brychius sp.	1	0.39	5	MH
Total Coleoptera	**34**	**13.39**		
Atherix sp.	2	0.79	4	PR
Ceratopogoninae	4	1.57	6	PR
Simulium sp.	1	0.39	6	CF
Tipulidae - early instar	1	0.39	3	UN
Hexatoma sp.	3	1.18	2	PR
Total Diptera	**11**	**4.33**		
Micropsectra sp.	1	0.39	7	CG
Pagastia sp.	1	0.39	1	CG
Paratanytarsus sp.	1	0.39	6	UN
Total Chironomidae	**3**	**1.18**		
Grand Total	**254**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Cottonwood Creek **Site ID: M22CTWDC01 8/21/01**

TOTAL ABUNDANCE	254
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	104
TOTAL NUMBER OF TAXA	34
Number EPT taxa	16

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	4	76	29.92
Odonata	0	0	0.00
Ephemeroptera	6	74	29.13
Plecoptera	4	9	3.54
Hemiptera	2	26	10.24
Megaloptera	0	0	0.00
Trichoptera	6	21	8.27
Lepidoptera	0	0	0.00
Coleoptera	4	34	13.39
Diptera	5	11	4.33
Chironomidae	3	3	1.18

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	34.67

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	7	47	18.50
Parasite	0	0	0.00
Collector-gatherer	11	136	53.54
Collector-filterer	3	9	3.54
Macrophyte-herbivore	1	1	0.39
Piercer-herbivore	1	4	1.57
Scraper	4	20	7.87
Shredder	2	6	2.36
Xylophage	0	0	0.00
Omnivore	2	7	2.76
Unknown	3	24	9.45

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	2.22
Scraper/(Scraper + C.filterer)	0.69
Shredder/Total organisms	0.01

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Physidae	55	21.65
Paraleptophlebia bicornuta	35	13.78
Oreodytes sp.	30	11.81
Corixidae - immature	22	8.66
Baetis tricaudatus	18	7.09
SUBTOTAL 5 DOMINANTS	160	62.99
Fossaria sp.	16	6.30
Nixe sp.	13	5.12
Hydropsyche sp.	7	2.76
Sweltsa sp.	5	1.97
Lepidostoma sp.-turret case lar	5	1.97
TOTAL DOMINANTS	206	81.1

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.56

DIVERSITY MEASURES

Shannon H (loge)	2.36
Shannon H (log2)	3.40
Evenness	0.67
Simpson D	0.09

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	21	8.37
Univoltine	194	76.28
Semivoltine	39	15.35

	#TAXA	ABUNDANCE	PERCENT
Tolerant	11	167	65.75
Intolerant	0	0	0.00
Clinger	9	32	12.60

Aquatic Invertebrate Taxonomic Data

Site Name: Cottonwood Creek

Site ID: M22CTWDC02 8/21/01

Approx. percent of sample used: 40

Taxon	Quantity	Percent	HBI	FFG
Polycelis coronata	3	0.99	4	CG
Nematoda	1	0.33	5	PA
Nais sp.	2	0.66	8	CG
Tubificidae - immature	19	6.27	9	CG
Physidae	9	2.97	8	CG
Caecidotea sp.	12	3.96	8	CG
Acari	2	0.66	5	PA
Total Misc. Taxa	**48**	**15.84**		
Diphetor hageni	2	0.66	5	CG
Caenis sp.	7	2.31	7	CG
Ephemera sp.	1	0.33	4	CG
Nixe sp.	19	6.27	2	SC
Paraleptophlebia bicornuta	12	3.96	4	CG
Tricorythodes minutus	40	13.20	4	CG
Total Ephemeroptera	**81**	**26.73**		
Sigara sp.	1	0.33	8	PH
Ambrysus sp.	1	0.33	11	PR
Total Hemiptera	**2**	**0.66**		
Brachycentrus occidentalis	2	0.66	1	OM
Helicopsyche borealis	39	12.87	7	SC
Hydropsyche sp.	52	17.16	4	CF
Hydroptila sp.	5	1.65	6	PH
Nectopsyche sp.	1	0.33	3	OM
Oecetis sp.	5	1.65	8	OM
Total Trichoptera	**104**	**34.32**		
Cleptelmis sp.	1	0.33	4	CG
Dubiraphia sp.	4	1.32	6	CG
Optioservus sp.	3	0.99	4	SC
Total Coleoptera	**8**	**2.64**		
Ceratopogoninae	2	0.66	6	PR
Total Diptera	**2**	**0.66**		
Cricotopus Bicinctus Gr.	7	2.31	7	CG
Micropsectra sp.	1	0.33	7	CG
Microtendipes sp.	4	1.32	6	CG
Parametriocnemus sp.	1	0.33	5	CG
Paratanytarsus sp.	2	0.66	6	UN
Rheocricotopus sp.	33	10.89	6	OM
Thienemanniella sp.	2	0.66	6	CG
Thienemannimyia Gr.	6	1.98	6	PR
Tvetenia sp.	2	0.66	5	CG
Total Chironomidae	**58**	**19.14**		
Grand Total	**303**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Cottonwood Creek **Site ID: M22CTWDC02 8/21/01**

TOTAL ABUNDANCE	303
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	185
TOTAL NUMBER OF TAXA	34
Number EPT taxa	12

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	7	48	15.84
Odonata	0	0	0.00
Ephemeroptera	6	81	26.73
Plecoptera	0	0	0.00
Hemiptera	2	2	0.66
Megaloptera	0	0	0.00
Trichoptera	6	104	34.32
Lepidoptera	0	0	0.00
Coleoptera	3	8	2.64
Diptera	1	2	0.66
Chironomidae	9	58	19.14

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	3.19

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	3	9	2.97
Parasite	2	3	0.99
Collector-gatherer	18	129	42.57
Collector-filterer	1	52	17.16
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	2	6	1.98
Scraper	3	61	20.13
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	4	41	13.53
Unknown	1	2	0.66

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	1.17
Scraper/(Scraper + C.filterer)	0.54
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Hydropsyche sp.	52	17.16
Tricorythodes minutus	40	13.20
Helicopsyche borealis	39	12.87
Rheocricotopus sp.	33	10.89
Tubificidae - immature	19	6.27
SUBTOTAL 5 DOMINANTS	183	60.40
Nixe sp.	19	6.27
Caecidotea sp.	12	3.96
Paraleptophlebia bicornuta	12	3.96
Physidae	9	2.97
Caenis sp.	7	2.31
TOTAL DOMINANTS	242	79.87

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.51

DIVERSITY MEASURES

Shannon H (loge)	2.43
Shannon H (log2)	3.51
Evenness	0.69
Simpson D	0.08

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	68	22.36
Univoltine	225	74.17
Semivoltine	11	3.47

	#TAXA	ABUNDANCE	PERCENT
Tolerant	11	126	41.58
Intolerant	0	0	0.00
Clinger	9	132	43.56

Aquatic Invertebrate Taxonomic Data

Site Name: Cottonwood Creek
Site ID: M22CTWDC03 8/21/01

Approx. percent of sample used: 10

Taxon	Quantity	Percent	HBI	FFG
Polycelis coronata	2	0.66	4	CG
Tubificidae - immature	2	0.66	9	CG
Physidae	9	2.98	8	CG
Acari	4	1.32	5	PA
Total Misc. Taxa	**17**	**5.63**		
Baetis tricaudatus	50	16.56	6	CG
Diphetor hageni	3	0.99	5	CG
Nixe sp.	2	0.66	2	SC
Tricorythodes minutus	15	4.97	4	CG
Total Ephemeroptera	**70**	**23.18**		
Perlodidae-early instar	3	0.99	2	PR
Total Plecoptera	**3**	**0.99**		
Helicopsyche borealis	5	1.66	7	SC
Hydropsyche sp.	50	16.56	4	CF
Hydroptila sp.	2	0.66	6	PH
Nectopsyche sp.	1	0.33	3	OM
Onocosmoecus unicolor	1	0.33	1	OM
Total Trichoptera	**59**	**19.54**		
Cleptelmis sp.	1	0.33	4	CG
Dubiraphia sp.	1	0.33	6	CG
Optioservus sp.	10	3.31	4	SC
Total Coleoptera	**12**	**3.97**		
Limnophora sp.	1	0.33	6	PR
Simulium sp.	4	1.32	6	CF
Hexatoma sp.	4	1.32	2	PR
Total Diptera	**9**	**2.98**		
Cricotopus Trifascia Gr.	62	20.53	6	CG
Dicrotendipes sp.	1	0.33	8	CG
Eukiefferiella Devonica Gr.	5	1.66	4	OM
Microtendipes sp.	2	0.66	6	CG
Parametriocnemus sp.	4	1.32	5	CG
Paratanytarsus sp.	2	0.66	6	UN
Polypedilum sp.	3	0.99	6	OM
Potthastia sp.	1	0.33	2	CG
Rheocricotopus sp.	38	12.58	6	OM
Tanytarsus sp.	1	0.33	6	CF
Thienemanniella sp.	2	0.66	6	CG
Thienemannimyia Gr.	11	3.64	6	PR
Total Chironomidae	**132**	**43.71**		
Grand Total	**302**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Cottonwood Creek **Site ID: M22CTWDC03 8/21/01**

TOTAL ABUNDANCE	302
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	132
TOTAL NUMBER OF TAXA	32
Number EPT taxa	10

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	4	17	5.63
Odonata	0	0	0.00
Ephemeroptera	4	70	23.18
Plecoptera	1	3	0.99
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	5	59	19.54
Lepidoptera	0	0	0.00
Coleoptera	3	12	3.97
Diptera	3	9	2.98
Chironomidae	12	132	43.71

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	1.00

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	4	19	6.29
Parasite	1	4	1.32
Collector-gatherer	14	155	51.32
Collector-filterer	3	55	18.21
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	2	0.66
Scraper	3	17	5.63
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	5	48	15.89
Unknown	1	2	0.66

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.31
Scraper/(Scraper + C.filterer)	0.24
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Cricotopus Trifascia Gr.	62	20.53
Baetis tricaudatus	50	16.56
Hydropsyche sp.	50	16.56
Rheocricotopus sp.	38	12.58
Tricorythodes minutus	15	4.97
SUBTOTAL 5 DOMINANTS	215	71.19
Thienemannimyia Gr.	11	3.64
Optioservus sp.	10	3.31
Physidae	9	2.98
Helicopsyche borealis	5	1.66
Eukiefferiella Devonica Gr.	5	1.66
TOTAL DOMINANTS	255	84.44

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.36

DIVERSITY MEASURES

Shannon H (loge)	2.20
Shannon H (log2)	3.17
Evenness	0.63
Simpson D	0.11

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	159	52.57
Univoltine	131	43.46
Semivoltine	12	3.97

	#TAXA	ABUNDANCE	PERCENT
Tolerant	11	96	31.79
Intolerant	0	0	0.00
Clinger	11	141	46.69